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(54) PRODUCTION OF STEEL SHEET HIGH IN BAKING HARDENABILITY
AND SMALL IN AGING DETERIORATION

(57)Abstract:

PROBLEM TO BE SOLVED: To production a steel sheet high in baking hardenability and free from the generation of aging deterioration without causing disadvantages in the points of the uniformity of the material and the stability of the operation.

SOLUTION: A slab having a compsn. contg., by weight, $\leq 0.01\%$ C, $\leq 0.10\%$ Si, $\leq 1.5\%$ Mn, $\leq 0.20\%$ P, $\leq 0.010\%$ S, 0.030 to 0.150% Al, $\leq 0.0040\%$ N, and the balance Fe with inevitable impurities is subjected to hot rolling so as to regulate the finish rolling temp. to 800 to 950°C and is coiled at $\geq 600^\circ\text{C}$, this hot rolled sheet is subjected to pickling and cold rolling, is thereafter subjected to decarburizing annealing by the quantity to be decarburized of $\geq 0.0005\text{wt.}\%$ by annealing treatment of holding to the recrystallization temp. or above for $\geq 10\text{sec}$ in an atmosphere in which the gaseous compsn. is composed of $\geq 3\%$ hydrogen, and the balance substantial nitrogen, and the dew point is regulated to $\geq -20^\circ\text{C}$ and is subjected to secondary cold rolling at a draft of 1 to 5%.

[Claim 1]C: Less than 0.01wt%, less than Si:0.10wt%, and less than Mn:1.5 wt%. P: Less than 0.20wt%, less than S:0.010 wt%, aluminum:0.030 - 0.150 wt%, Contain less than N:0.0040wt% and the remainder slab which becomes the presentation of Fe and inevitable impurities, Hot-roll by the finishing rolling temperature 800 - 950 **, and it rolls round above 600 **, After performing pickling and cold rolling to this hot-rolling board, not less than 3% of hydrogen and the remainder consist of nitrogen substantially, and gas composition in atmosphere whose dew point is more than -20 **, A manufacturing method of few baking hardenability steel plates of age deterioration carrying out decarburization annealing beyond amount of decarbonization 0.0005wt% to temperature more than recrystallizing temperature, and carrying out secondary cold

rolling of 1 to 5% of rolling reduction to it by an annealing process held 10 seconds or more.

[Claim 2]In claim 1, steel composition contains further one sort chosen from Nb:0.003 - 0.040 wt% and Ti:0.003 - 0.040 wt%, or two sorts, and this Nb and Ti are following formulas, respectively.;

$\{C \text{ (wt\%)} / 12\} \{Nb \text{ (wt\%)} / 93\} / 48 / \{C \text{ (wt\%)} / 12\} \leq 0.8$, however $Ti^* \text{ (wt\%)} = Ti \text{ (wt\%)} - (48/32) \times S \text{ (wt\%)} - (48/14) \times N \text{ (wt\%)} [\leq 0.8 \text{ and } \{Ti^* \text{ (wt\%)} / 48\}]$

A manufacturing method of few baking hardenability steel plates of age deterioration becoming the presentation with which ***** is filled.

[Claim 3]A manufacturing method of few baking hardenability steel plates of age deterioration, wherein steel composition turns into a presentation containing B:0.0002 - 0.0020wt% further in claim 1 or 2.

[Claim 4]In any 1 paragraph of claims 1-3, steel composition further Cu:0.01 - 0.2 wt%, nickel: A manufacturing method of few baking hardenability steel plates of age deterioration becoming the presentation containing any one sort chosen from Cr:0.01 - 0.2 wt% and Mo;0.01 - 0.2 wt%, or two sorts or more 0.01 - 0.2 wt%.

[Claim 5]A manufacturing method of few baking hardenability steel plates of age deterioration given in any 1 paragraph of claims 1-4 depositing not less than 80% of the amount of N in steel as AlN in a hot-rolling board.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the manufacturing method of a baking hardenability steel plate.

Like especially the panels of a car, the dent-proof nature after processing uses for the required purpose for spending, and it is related with the suitable manufacturing method of the steel plate which there is little age deterioration, it moreover prints and has hardenability.

[0002]

[Description of the Prior Art]As for the baking hardenability steel plate for press working of sheet metal, what can manufacture the processed products which are elasticity in the time of shaping, generally have the characteristic made hard in the baking process after fabricating and painting by heating (in general 170 °C x 20 minutes) processing, and were eventually provided with sufficient intensity is ideal. From the former, some researches for giving such the characteristic have been done. For example, the method which is going to control the amount of dissolution C in steel in the proper range is indicated by JP,5-48283,B by mainly specifying a steel composition. the method of controlling the amount of C of a dissolution state is indicated by JP,57-192225,A by adding Nb instead of Ti and controlling the dissolution of Nb, and a deposit action as similar art. By carrying out elevated-temperature annealing above 850 °C, making a part of NbC of a

separation state re-dissolve, and quenching from that state, this method tends to prevent a re-deposit and tends to secure the amount of dissolution C of an appropriate range.

[0003]

[Problem(s) to be Solved by the Invention]However, the region which fills the latest request level in a baking hardenability steel plate also by such conventional technologies is not arrived at. That is, the concrete characteristics demanded were high baking hardenability (40 or more MPa), a good r value, and the low room temperature age deterioration characteristic, and were difficult to reconcile baking hardenability and the room temperature age deterioration characteristic especially in the above-mentioned conventional technology. That is, when it is going to secure the big amount of baking hardening and the amount of dissolution C was made to increase, the room temperature prescription characteristic deteriorates, there is a danger of generating a stretcher strain at the time of press forming, and becoming an appearance defect, and the manufacturing method with which it can be industrially satisfied of both the characteristics did not exist.

[0004]How to control atmosphere by a annealing process and carburize as conventional technology which prints controlling a stretcher strain and makes hardenability profitably like (for example, JP,8-14019,B)

b) How to carry out continuous annealing of the extremely low carbon steel in a two-phase region (for example, JP,2-232316,A)

Although there was ****, all had a problem in respect of the homogeneity of construction material, and the stability of operation. In the above-mentioned a, since the furnace atmosphere was made into strong carburization atmosphere, when processing the material which does not perform carburization in an identical line, the problem had especially been produced. In the above-mentioned b, the problem of being indispensable has also made the presentation of a steel plate into a special component system.

[0005]In order to measure the room temperature age deterioration characteristic according to artificers' investigation examination, The fact carried out at the temperature of about 100 ** based on the rule of thumb about the equivalence of temperature and time adopted also in the above-mentioned conventional technology that actual age deterioration could not be simulated in the conventional accelerated test became clear. And as a measuring method of the room temperature age deterioration characteristic with more sufficient simulation nature, the good thing was also understood that it makes prescription temperature into an about 50 ** elevated temperature (it becomes storage at a temperature of this level when performing export etc., and passing through the equator) in consideration of the severest conditions that may be attained in the usual state of preservation. An appearance of the baking hardenability steel plate which can also bear the right valuation method of the room temperature age deterioration characteristic based on the actual operating environment from such a thing was desired.

[0006]Then, while the main purpose of this invention has big baking hardenability so that the parts which carried out after [press forming] paint baking can secure sufficient intensity in view of the problem which the above-mentioned conventional technology was holding, It is in providing the art of manufacturing the steel plate which does not

produce age deterioration (stretcher-strain generating at the time of press forming) without causing disadvantage in respect of the homogeneity of construction material, or the stability of operation. The amount of baking hardening (BH) the concrete purpose of this invention 40 or more MPa, The breakdown point elongation after the prescription for 50 ** to three months. 0.2% or less and an r value (field Hitoshi Uchihira) are 1.8. It is in providing the art of manufacturing the steel plate which has the above construction material characteristic without causing disadvantage in respect of the homogeneity of construction material, or the stability of operation.

[0007]

[Means for Solving the Problem]Artificers acquired knowledge shown below, as a result of repeating an experiment and research wholeheartedly about a steel composition, rolling, a heat treatment condition, etc., in order to solve the above-mentioned problem.

1) Extremely low carbon steel in which a high r value is obtained easily is [steel composition] suitable. It is also effective from a viewpoint of stabilization of construction material to add a carbon nitride formation element selectively and to secure the amount of C of a dissolution state.

2) In the conventional continuous annealing process, the target construction material characteristic is obtained by using positively for the above-mentioned extremely low carbon steel a decarbonization phenomenon in an annealing furnace for which it was striving to control as much as possible. That is, it becomes possible by making the dew point high with more than -20 **, printing inside a steel plate and making sufficient dissolution C to secure hardenability remain by a continuous annealing process, while producing decarbonization in a steel sheet surface and reducing prescription nature to reconcile baking hardenability and age deterioration-proof nature.

[0008]This invention is constituted based on the above knowledge, and the place made into the gist is as follows.

1) Less than C:0.01wt%, less than Si:0.10wt%, and less than Mn:1.5 wt%. P: Less than 0.20wt%, less than S:0.010 wt%, aluminum:0.030 - 0.150 wt%, Contain less than N:0.0040wt% and the remainder slab which becomes the presentation of Fe and inevitable impurities, Hot-roll by the finishing rolling temperature 800 - 950 **, and it rolls round above 600 **, After performing pickling and cold rolling to this hot-rolling board, not less than 3% of hydrogen and the remainder consist of nitrogen substantially, and gas composition in atmosphere whose dew point is more than -20 **, A manufacturing method of few baking hardenability steel plates of age deterioration carrying out decarburization annealing beyond amount of decarbonization 0.0005wt% to temperature more than recrystallizing temperature, and carrying out secondary cold rolling of 1 to 5% of rolling reduction to it by an annealing process held 10 seconds or more.

[0009]2) In the above 1, steel composition contains further one sort chosen from Nb:0.003 - 0.040 wt% and Ti:0.003 - 0.040 wt%, or two sorts, and this Nb and Ti are following formulas, respectively.;

$\{C \text{ (wt\%)} / 12\} \{Nb \text{ (wt\%)} / 93\} / 48 / \{C \text{ (wt\%)} / 12\} \leq 0.8$, however $Ti^* \text{ (wt\%)} = Ti \text{ (wt\%)} - (48/32) \times S \text{ (wt\%)} - (48/14) \times N \text{ (wt\%)}$ [≤ 0.8 and $\{Ti^* \text{ (wt\%)} / 48\}$]

A manufacturing method of few baking hardenability steel plates of age deterioration becoming the presentation with which ***** is filled.

[0010]3) A manufacturing method of few baking hardenability steel plates of age deterioration, wherein steel composition turns into a presentation containing B:0.0002 - 0.0020wt% further in the above 1 or 2.

[0011]In any one of the above 1-3, steel composition further 4) Cu:0.01 - 0.2 wt%, nickel: A manufacturing method of few baking hardenability steel plates of age deterioration becoming the presentation containing any one sort chosen from Mo;0.01 - 0.2 wt%, or two sorts or more 0.01 - 0.2 wt%Cr:0.01 - 0.2 wt%.

[0012]5) A manufacturing method of few baking hardenability steel plates of age deterioration of any one statement of the above 1-4 depositing not less than 80% of the amount of N in steel as AlN in a hot-rolling board which is a cold-rolled negative.

[0013]

[Embodiment of the Invention]Next, the reason which limited component composition, manufacturing conditions, etc. as the above-mentioned gist composition is explained.

(1) Less than C:0.01wt%C is a harmful element from processability about a steel composition, and the stable high r value and good ductility can be obtained by reduction of C. In order to acquire such an effect, when it is necessary to make the amount of C less than 0.01wt% and the field of an r value is taken into consideration, decreasing to less than 0.004 wt% is desirable. moreover -- in order to acquire effective baking hardenability -- in general -- more than 0.001 wt% -- it is preferred to make it contain.

[0014]Si: If it adds [less than 0.10wt%Si] so much, since degradation of surface treatment nature, corrosion-resistant degradation, etc. will be caused, it makes the maximum 0.10wt%. When the especially outstanding corrosion resistance is required, restricting to less than 0.02wt% is preferred.

[0015]Mn: When less than 1.5 wt%Mn prevents hot tearing resulting from S, it is an effective element, and it is good to add according to the amount of S to contain. Mn carries out minuteness making of the crystal grain, and is an element effective in improvement in construction material. in order to demonstrate these effects -- more than 0.1 wt% -- adding is desirable. On the other hand, since corrosion resistance will fall and flange processability will deteriorate although high intensity-ization of a steel plate can be attained if Mn is added so much, a maximum is made into 1.5 wt%. For the use as which a better moldability is required, less than 0.80wt% is desirable.

[0016]P: When less than 0.20wt%P attained high intensity-ization by solid-solution-strengthening operation, it was a useful element, but when contained so much, while making steel make it hard and degrading flange processability and neck processability, in order to reduce corrosion resistance, it made the maximum 0.20wt%. When thinking processability and corrosion resistance as important, it is preferred to hold down to less

than 0.01wt%.

[0017]S: Less than 0.010 wt%S is an element which exists as inclusion in steel, decreases ductility, and brings about further corrosion-resistant degradation. Since these influences will appear notably if S content exceeds 0.010 wt%, they are restricted to less than 0.010 wt%. It is desirable to control especially for the use as which good processability is required at less than 0.005 wt%.

[0018]Although aluminum:0.030 -0.150 wt%aluminum is an element required since it is stabilized and N is fixed and addition beyond 0.030 wt% is required for it, Since it will lead to the phenomenon of generating of the flange crack by degradation of a surface disposition, increase of the anisotropy of a rolling direction, and elasticity-izing of a weld zone if contained so much, the maximum is made into 0.150 wt%. In order [of construction material / further] to be stable, it is desirable to add in 0.040 - 0.080 wt% of the range.

[0019]N: Less than 0.0040wt%N is an element to which prescription nature is made to increase, and is an element in which the degree of dissolution in the inside of a ferrite is also large, and control of the amount of dissolution is important. In this invention, the baking hardening characteristic was not depended on N, but it aims at obtaining only by C. Although the amount of dissolution of N is reduced and being got by the above-mentioned addition aluminum, it becomes difficult to be stabilized if the total amount of N in steel exceeds 0.0040wt%, and to fix the dissolution N. therefore, the amount of N -- less than 0.0040wt% -- less than 0.0020wt% is used preferably.

[0020]The element stated to the next other than the above basic element can be added selectively.

Nb: By forming carbon nitride, 0.003 - 0.040 wt%, and $\{Nb(wt\%)/93\} / \{C (wt\%)/12\} \leq 0.8$ Nb are effective in reducing the dissolution C and N, and its minuteness making effect of a crystal grain is also remarkable. Although these effects are demonstrated by addition beyond 0.003 wt%, if it adds exceeding 0.040 wt%, steel will become hard and the danger of it not only causing trouble, but generating a crack at a slab casting process at a cold rolling process will increase. Therefore, although the maximum of the addition of Nb is made into 0.040 wt%, it is desirable to consider it as 0.02wt%, for it is stabilized and securing the amount of baking hardening. If the atomic ratio of Nb and C, i.e., $\{Nb(wt\%)/93\} / \{C (wt\%)/12\}$ exceeds 0.8, it will become difficult to acquire the baking hardenability of sufficient target quantity. For this reason, it is said atomic ratio 0.8 0.75 or less are used preferably hereafter.

[0021]Ti:0.003 - 0.040 wt%, and $\{Ti^*(wt\%)/48\} / \{C (wt\%)/12\} \leq 0.8$ however $Ti^*(wt\%) = Ti(wt\%) - (48/32) \times S(wt\%) - (48/14) \times N (wt\%)$

Ti is also an element effective in reducing the amount of dissolution C like Nb, and the minuteness making of an organization. Although such an effect is demonstrated by addition beyond 0.003 wt%, it will print, if it adds exceeding 0.04wt%, and the amount of hardening falls. Therefore, as for the addition of Ti, it is desirable to consider [which is made into 0.003 - 0.040 wt%] it as 0.005 - 0.020 wt% of the range in addition, in order

to be stabilized and to secure the amount of baking hardening. The atomic ratio of Ti and C, i.e., $\{Ti^*(wt\%)/48\} / \{C (wt\%)/12\} \leq 0.8$, However, if $Ti^*(wt\%) = Ti(wt\%) - (48/32) \times S(wt\%) - (48/14) \times N(wt\%)$ ** exceeds 0.8, it will become difficult to acquire the baking hardenability of sufficient target quantity. For this reason, it is said atomic ratio 0.8 0.75 or less are used preferably hereafter.

[0022]B: 0.0002-0.0020wt%B is an alloying element effective in improving the room temperature-proof prescription characteristic, without reducing the baking hardenability of a steel plate, although a detailed mechanism is not necessarily clear. Although such an effect is demonstrated by addition beyond 0.0002wt%, since this effect is not only saturated, but the plane anisotropy of the mechanical property of a steel plate will increase if it adds exceeding 0.0020wt%, it is added in 0.0002 - 0.0020wt% of the range. It is preferred to add in 0.0005 - 0.0010wt% of the range from the point of stabilization of mechanical properties and equalization.

[0023]Cr:0.01 - 0.2 wt% and Mo;0.01-0.2 wt%Cu, nickel, Cr, and Mo nickel:0.01 - 0.2 wt% Cu:0.01 - 0.2 wt%, The intensity of a steel plate can be made to increase, without having an almost similar construction material improvement effect, and causing ductile big degradation. Although such an effect is demonstrated from addition beyond 0.01wt%, even if it adds exceeding 0.2 wt%, the danger that in addition to an effect being saturated a hot-rolling motherboard will become hard and will generate the fault in a cold rolling process increases. Since the above-mentioned effect is not offset even if it carries out compound addition of these elements, either of independent addition and compound addition is obtained.

[0024](2) About manufacturing conditions, perfect solution-ization should just be made and heating of the steel stock before - hot-rolling hot-rolling should just be heated beyond Ac_3 point. Specifically, 1050-1300 ** is suitable. In hot-rolling following the above-mentioned heating, finishing rolling temperature is important from the r value of a steel plate, and a viewpoint of ductile reservation. And in order to print with a high target r value and to obtain the hardening characteristic, it is finishing rolling temperature. It is required to consider it as not less than 800 **. However, when it rolls by finishing exceeding 950 **, the load of hot-rolling RORUHE increases, and also big and rough-ization of an organization also becomes remarkable. therefore, finishing hot-rolling temperature 800-950 ** -- it is preferably considered as the temperature requirement of 840 - 920 **.

[0025]- Rolling-up temperature rolling-up temperature affects the immobilization where N by aluminum was stabilized. rolling-up temperature -- not less than 600 ** -- desirable -- deposit immobilization of N according to aluminum by using not less than 650 ** -- a hot-rolling coil -- it can attain covering an overall length mostly. Although the maximum in particular of rolling-up temperature is not defined, when it takes controlling aggravation of descaling nature into consideration, it is good to hold down to below 780 **.

[0026]- With a hot-rolling board, not less than 80% of the amount of N in steel, as AlN, pickling and after cold-rolling is carried out, continuous annealing of the deposit hot-rolling board is carried out. Although a part of dissolution N deposits as AlN in the case of this annealing, since it is a short time, it is difficult to deposit the dissolution N thoroughly. If N of a dissolution state exists after annealing, recovery of the age deterioration in a room temperature, especially breakdown point elongation will become remarkable. For this reason, as for N, it is desirable in the stage of a hot-rolling board not less than 80% or to deposit not less than 85 more% of the amount of N in steel. N of the separation state specified here analyzed AlN by electrolytic extraction analysis usually carried out, and also it puts the amount (N as AlN) ** of N computed from equivalent relations. In order to carry out deposit immobilization of the inside N of steel in a mentioned range, control of the coiling temperature after hot-rolling mentioned above is very important. In addition, they are at least 1-hour or more heat retaining or a means also with leading also cooling slowly about the rolled-round coil.

[0027]- A continuous-annealing continuous annealing process is one of the especially important requirements in this invention. Not less than 3% of hydrogen and the remainder consist of nitrogen substantially, and gas composition carries out continuous annealing held 10 seconds or more to the temperature more than recrystallizing temperature, and makes it produce the decarbonization beyond 0.0005wt% (decarbonizing) in an annealing process in the atmosphere whose dew point is more than -20 **. Thus, by producing decarbonization beyond 0.0005wt% eventually, it becomes possible to reconcile sufficient baking hardenability aimed at by this invention, and the outstanding room temperature-proof prescription nature. Although the detailed mechanism of a decarbonization phenomenon is not necessarily clear, it presumes as follows. Decarbonization uses a surface reaction, and it produces the concentration gradient of big C from a surface toward the inside of a steel plate in a short-time nonequilibrium state in order to remove C in steel from the layer part of a steel plate at a solid breath object reaction as CO (or called CH₃ and CO₂). Although it is difficult to actually analyze the concentration distribution in the board thickness direction of this C, when it calculates by assuming a reaction to be a diffusion limitation of C, it comes to be shown in drawing 1. It can say that this analysis result is appropriate to some extent from corresponding well with C analytical value after [before C content with which it integrated to the board thickness direction annealing] annealing. Such a concentration gradient can maintain this state to a room temperature, if it quenches after soak like continuous annealing (not less than at least 10 **/(sec)).

[0028]Thus, in the attained state of having a concentration gradient of the board thickness direction of C, when secondary rolling of 1 to 5% of rolling reduction is performed, a movable rearrangement will be introduced into the field with very few amounts of C of a layer part. namely, adherence according [the movable rearrangement introduced into a layer part] to C -- easy -- **** -- **** -- it becomes things. By this, the outstanding room temperature-proof prescription nature will appear. On the other hand, in the stage which uses a product, after the plastic-working distortion of not less than about at least 5% is given, aging treatment for about 20 minutes will be performed by about 170 **. In this case, naturally modification is started over the thickness direction whole region of a

steel plate, and many rearrangements are introduced newly. And in the case of prescription, in steel, since the dissolution C of sufficient quantity which adheres these the rearrangements of a lot of remains, the big target baking hardening characteristic is shown.

[0029]In order to produce the above effective decarbonization reactions, it is necessary to consider it as continuous annealing in which rapid heating and forced cooling are possible, and to make the remainder into the annealing atmosphere which consists of nitrogen substantially including not less than 3% of hydrogen in that case. the dew point - more than -20 °C -- desirable -- 1 °C -- it is necessary to consider it as not less than 10 °C, and to perform annealing held 20 seconds or more desirably about 10 seconds or more above recrystallizing temperature Although the maximum in particular of annealing time is not defined, if the efficiency of a actual production process is taken into consideration, it is desirable to use less than 40 seconds. Although the maximum in particular of hydrogen concentration is not defined, if the cost of a controlled atmosphere and the stability of operation are taken into consideration, it is desirable to use 10% or less of concentration. If the amount of C in steel annealing before and after annealing was measured by board thickness direction penetration analysis and the difference has produced the decarbonization which is more than 0.0005wt% as an amount of decarbonization, the outstanding room temperature-proof prescription nature for which it asks, and sufficiently big baking ***** will be obtained. Although the profile of the depth direction should be considered essentially, if it is the steel composition of this invention, and manufacturing conditions, penetration analysis of a board thickness direction can be substituted.

[0030]- Secondary secondary cold rolling cold rolling is usual. Although it carries out at the lightly pressurizing rate of about 0.8%, in order to raise sufficient room temperature-proof prescription characteristic, in this invention, it is necessary to give rolling of rolling reduction higher than these. That is, the breakdown point elongation by prescription in 50 °C 1 three months made into a target can be controlled below to 0.2 % by giving 1% or more of pressing down. However, if pressing down exceeding 5% is performed, the ductility of a steel plate, and since especially uniform elongation falls, the danger of producing faults, such as a crack, at the time of press forming will increase. Therefore, let rolling reduction of secondary cold rolling be the rolling reduction of 1 to 5%. When the room temperature-proof prescription characteristic of having excelled further is required, it is desirable to give a rolling strain with 2 to 3% of rolling reduction.

[0031]the target construction material [this invention] characteristic -- an r value (field Hitoshi Uchihira) -- 1.8 -- the amount of baking hardening (BH) besides above -- more than 40 MPa -- breakdown point elongation after the prescription for 50 °C to three months It may be 0.2% or less. The amount of baking hardening guarantees the strength property at the time of use of forming parts. Although it is changed with the board thickness of a steel plate, and an intensity level, if the value has the amount of baking hardening more than 40 MPa in general in the application parts of the steel plate which has the moldability extremely outstanding like this invention, it is enough in practical use. Although the room temperature prescription characteristics also differ with the target

parts etc., if the prescription for 50 ** 1 three months is borne, it is enough practically in general. If the value of such breakdown point elongation recovered by an aging condition is below 0.2 %, the appearance defect by stretcher-strain generating will not be produced at the time of press forming.

[0032]

[Example]

The example of this invention is described to the primary example. Steel of the component composition shown in Table 1 was ingoted with the converter, hot-rolling, continuous annealing, and secondary cold rolling were performed on the conditions which show this steel slab in Table 2, and the last board thickness was used as the cold rolled sheet steel of 0.7 mm. Thus, from the obtained steel plate, the JIS No. 5 specimen was extracted from one fourth of the positions of the plate width direction, it baked with the usual mechanical property, and hardenability (BH nature) was investigated. About room temperature prescription nature, the thermostat was used for the test piece for tensile test extracted similarly, and prescription for 50 ** 1 three months was given. These results of an investigation are shown in Table 3. Baking hardenability (BH nature) was searched for as follows. That is, after giving 2% of prestrain, unloading was once carried out, the prescription for 20 minutes was given in 170 **, tension was performed again, and the difference of the flow stress in front of prescription and the yield stress after prescription was made into the amount of BHs. The r value was calculated as an average r value with the following formula.

$r = (r_0 + r_{90} + 2r_{45}) / 4$, however r-value r_{45} of a direction that makes an r-value r_{90} :rolling direction and 90 inclination to an r_0 :rolling direction: The r value of a rolling direction and the direction which makes 45 inclination

[0033]

[Table 1]

鋼 No	化 学 組 成 (wt%)								摘 要
	C	Si	Mn	P	S	Al	N	その他	
1	0.0030	0.01	0.10	0.010	0.004	0.040	0.0015	Nb/0.008	適合鋼
2	0.0022	0.01	0.30	0.005	0.005	0.050	0.0018		適合鋼
3	0.0070	0.01	0.25	0.006	0.001	0.080	0.0025		適合鋼
4	0.0124	0.01	0.15	0.015	0.007	0.028	0.0020	Ti/0.006	適合鋼
5	0.0105	0.01	0.10	0.007	0.008	0.120	0.0022	Mo/0.02	適合鋼
6	0.0012	0.01	0.45	0.006	0.015	0.081	0.0028	Nb/0.006, B/0.0005	適合鋼
7	0.0013	0.01	0.25	0.006	0.009	0.060	0.0011	Cu/0.05, Ni/0.05, Cr/0.05	適合鋼
8	0.0025	0.01	0.55	0.004	0.010	0.050	0.0012	Nb/0.003, Ti/0.005	適合鋼
9	0.0350	0.01	0.15	0.006	0.002	0.040	0.0015		比較鋼

[0034]

[Table 2]

スラブ 加熱温度 (℃)	熱間圧延		繰取り 温度 (℃)	冷間圧延		連続焼鈍				2次冷延 圧下率 (%)
	仕上げ 温度 (℃)	仕上げ 厚み (mm)		厚み (mm)	圧下率 (%)	温度 (℃)	ガス組成	露点 (℃)	時間 (秒)	
1150	880	2.6	700	0.73	72	840	3% H_2 残り N_2	-10	30	2

[0035]

[Table 3]

鋼 No	熱延板の N 中N as AlN (%)	焼鈍後 C 量 (wt%)	脱炭量 (wt%)	r 値	伸 び (%)	TS (MPa)	BH (MPa)	室温時刻 後の降伏 伸び (%)	摘 要
1	95	0.0009	0.0021	2.1	49	310	45	0	発明例
2	90	0.0011	0.0011	2.0	48	315	47	0	発明例
3	95	0.0035	0.0035	1.8	46	330	51	0	発明例
4	85	0.0040	0.0084	1.8	45	340	50	0	発明例
5	85	0.0080	0.0025	1.8	45	350	52	0	発明例
6	95	0.0006	0.0006	2.0	49	309	41	0	発明例
7	95	0.0004	0.0009	1.9	46	380	55	0	発明例
8	90	0.0015	0.0010	1.9	47	330	48	0	発明例
9	82	0.0320	0.0030	1.1	43	350	50	7.0	比較例

[0036]The steel plate manufactured by this invention method being extended with a high r value, having (El), and having the baking hardening characteristic more than 40 MPa from Tables 1-3, by severe prescription, since breakdown point elongation is not produced, the appearance defect what is called accompanying stretcher-strain generating is not produced, either. Also in press forming with this actual, the rise of the part intensity by BH nature as expected and control of stretcher-strain generating were attained. Although experimented by setting annealing conditions as the range of this invention like the above experiment with the continuation hot-dip-zinc-coated-carbon-steel-sheet production line, the outstanding moldability (a high r value, high El) and high BH nature were obtained like the case of the cold rolled sheet steel mentioned above, and there was no degradation by room temperature prescription. Therefore, it turned out that this invention is satisfactorily applicable also not only to cold rolled sheet steel but a hot-dip zinc-coated carbon steel sheet (and alloying hot-dip zinc-coated carbon steel sheet). Although it is natural, it is [after manufacturing cold rolled sheet steel] satisfactorily [at all] applicable also to the use which performs electrogalvanizing etc.

[0037]Cold rolled sheet steel was manufactured to the steel 1 of the example 2 table 1 by the manufacturing conditions shown in Table 4, and the Zn-nickel alloy-plating steel plate was manufactured in the continuous system electroplating line. Then, after painting and burning resin on the surface, mechanical properties, BH nature, and the age deterioration characteristic in the room temperature were investigated like Example 1. The result is shown in Table 5. Since the resin coating composite-coatings steel plate

manufactured by this invention method does not produce breakdown point elongation in the above severe prescription, having a high r value and elongation and having the baking hardening characteristic of 40 or more MPa, it does not produce the appearance defect accompanying stretcher-strain generating. Also in actual press forming, the rise of the part intensity by BH nature as expected and control of stretcher-strain generating were attained.

[0038]

[Table 4]

No	スラブ 加熱 温度 (℃)	熱延 仕上げ 温度 (℃)	巻取り 温度 (℃)	熱延板の N 中 N 及 AlN (%)	冷延 圧下率 (%)	連続焼鈍				脱炭量 (wt%)	2 次 冷延 圧下率 (%)	摘 要
						温 度 (℃)	ガス組成	露 点 (℃)	時 間 (秒)			
1	1150	880	680	90	75	850	3%H ₂ - 残N ₂	-10	25	21	2	発明例
2	1160	900	710	95	75	880	4%H ₂ - 残N ₂	-15	30	18	3	発明例
3	1150	910	650	85	80	840	4%H ₂ - 残N ₂	-5	20	22	3	発明例
4	1100	850	700	90	73	840	5%H ₂ - 残N ₂	0	15	25	2	発明例
5	1120	850	710	90	73	840	3%H ₂ - 残N ₂	-10	20	22	1.5	発明例
6	1250	900	680	85	78	830	5%H ₂ - 残N ₂	-15	35	20	2	発明例
7	1230	900	680	85	78	830	5%H ₂ - 残N ₂	-15	20	20	2	発明例
8	1200	900	690	85	75	820	4%H ₂ - 残N ₂	-10	15	23	2	発明例
9	1200	870	700	96	75	840	4%H ₂ - 残N ₂	-10	20	22	1.5	発明例
10	1200	900	540	70	75	820	4%H ₂ - 残N ₂	-10	20	20	1.6	比較例
11	1200	880	710	88	75	840	N ₂ ~100 %	-10	20	1	1.8	比較例
12	1200	890	700	88	75	840	4%H ₂ - 残N ₂	-10	20	22	8	比較例

[0039]

[Table 5]

No	r 値	伸 び (%)	T S (MPa)	BH (MPa)	室温時効 後の降伏 伸び (%)	摘 要
1	2.02	48	315	45	0	発明例
2	2.14	49	310	42	0	発明例
3	1.95	47	320	43	0	発明例
4	2.05	49	315	41	0	発明例
5	1.98	48	325	43	0	発明例
6	2.10	49	312	44	0	発明例
7	1.85	47	330	45	0	発明例
8	1.88	47	331	51	0	発明例
9	1.92	46	325	44	0	発明例
10	1.40	46	320	45	0.5	比較例
11	1.70	45	325	45	1.5	比較例
12	1.78	33	380	20	0	比較例

[0040]

[Effect of the Invention]In [according to / as explained above / this invention] the continuous annealing process hot-rolling and after carrying out cold-rolling the steel stock of the specific component range, It becomes possible by being decarbonized, forming the concentration distribution of C in a board thickness direction positively, and giving temper rolling higher further comparatively to both be stabilized and to satisfy the difficult, sufficiently big paint baking hardenability and the outstanding age deterioration-proof characteristic of making it conventionally compatible. Therefore, since the steel plate by this invention shows the part intensity which rose and excelled [hardening / baking] in intensity greatly when it is excellent in a moldability and is actually used as a product by elasticity at the time of press forming and an assembly, the gauge down of a steel plate required to obtain same part intensity of it is attained. Although it is natural, the steel plate by this invention can be used also as various kinds of plating negatives.

